Zurich University
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Returns on Investment in Prevention and Health Promotion Measures in Switzerland

Review of methodological literature on economic evaluation of health promotion and prevention with focus on cost-benefit analysis

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Abstract

The current literature was non-systematically reviewed on economic evaluations in the fields of health promotion and prevention with focus on cost-benefit analysis (CBA). We present the main principles and procedures of a CBA of public health interventions according to the current state of the art and report the main difficulties. Furthermore, we introduce the framework of a CBA and the categories of costs and benefits. There are several different concepts to measure benefits in terms of final health outcome and to value benefits in monetary terms. When conducting an economic evaluation, it is essential to clearly state and justify the study design and to follow established guidelines, where they can be applied. Costs and benefits accounted for should be clearly reported and justified. Results should be discounted appropriately and be subject to an extensive sensitivity analysis.

Die aktuelle Literatur über ökonomische Evaluationen im Gebiet der Gesundheitsförderung und Prävention wurde unsystematisch durchgesehen mit dem Schwerpunkt auf die Kosten-Nutzen-Analyse (KNA). Wir zeigen die Hauptrichtlinien und Vorgehensweisen für eine KNA von einer Massnahme der öffentlichen Gesundheit gemäss dem aktuellen Stand der Dinge und weisen die Hauptschwierigkeiten aus. Ausserdem präsentieren wir das Gerüst einer KNA und die Kategorien der Kosten und des Nutzen. Um den Nutzen hinsichtlich des endgültigen Gesundheitszustands zu messen und den Nutzen in Geldeinheiten zu bewerten, gibt es verschiedene Konzepte. Beim Durchführen einer ökonomischen Evaluation gilt es die Wahl des Studiendesigns klar zu nennen und zu begründen und etablierte Richtlinien zu befolgen, wo diese angewandt werden können. Berücksichtigte Kosten und Nutzen sollten transparent ausgewiesen und begründet werden. Resultate sollten angemessen diskontiert werden und einer ausführlichen Sensitivitätsanalyse unterliegen.

La littérature actuelle sur les évaluations économiques dans le domaine de la prévention et de la promotion de la santé centrées sur l'analyse coûts-bénéfices (ACB) a été revue de façon non systématique. Nous présentons les plus récents principes et principaux procédés d'une ACB des interventions en santé publique, avec leurs principales difficultés. Nous présentons également la structure de l'ACB et les catégories de coûts et de bénéfices. Il existe plusieurs concepts pour mesurer les bénéfices en termes de résultat final sur l'état de santé et pour évaluer les bénéfices monétaires. Lorsque l'on effectue une analyse économique, il est essentiel de spécifier et de justifier clairement le type d'étude et de suivre les lignes directrices établies, là où elles peuvent s'appliquer. Les coûts et les bénéfices pris en compte devraient être explicitement rapportés et justifiés. Les résultats devraient être actualisés de façon appropriée et être soumis à une analyse de sensibilité.

Key Words

Methodology, economic evaluation, cost-benefit analysis, prevention, health promotion

Methodologie, ökonomische Evaluation, Kosten-Nutzen-Analyse, Prävention, Gesundheitsförderung

Méthodologie, évaluation économique, analyse coûts-avantages, prévention, promotion de la santé

Contents

List of abbreviations

BMI	Body Mass Index
BMJ	British Medical Journal
CBA	Cost-Benefit Analysis
CCA	Cost-Consequence Analysis
CEA	Cost-Effectiveness Analysis
CUA	Cost-Utility Analysis
DALY	Disability Adjusted Life Year
FOPH	Swiss Federal Office of Public Health
HYE	Healthy-years equivalent
HRQoL	Health-related quality of life
IRENE	Institute de recherches économiques (Université de Neuchâtel)
OECD	Organisation for Economic Co-operation and Development
QALY	Quality Adjusted Life Year
RCT	Randomised Control Trial
ROI	Return on investment
WHO	World Health Organizations
WIG	Winterthur Institute of Health Economics (Winterthurer Institut für Gesundheitsökonomie)
WTP	Willingness to pay
YHL	Years of Healthy Life
ZHAW	Zurich University of Applied Sciences (Zürcher Hochschule für Angewandte Wissenschaften)

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1 Introduction

When a politician has to decide whether to adopt a new public health measure, such as a ban of advertisements for alcoholic beverages, a law obliging cyclists to wear helmets or an educational programme on healthy nutrition in primary schools, he or she should ask two questions: *Does it work?,* and *Is it worth it*? Finding the answers to these questions is the task of evaluations by public health professionals and economists.

The goal of this report is a short review of the current literature on economic evaluation in the field of health promotion and prevention with a focus on cost-benefit analysis (CBA). It is part of a research project commissioned by the Swiss Federal Office of Public Health (FOPH) to the Winterthur Institute of Health Economics (WIG)[1] and the Institute of Economic Research (IRENE) of the University of Neuchatel, which includes CBAs of prevention measures in the fields of road accidents, alcohol abuse and tobacco in Switzerland in the last 20 to 30 years[2] and an exploratory study on obesity.

This report is not a systematic literature review on economic evaluations of interventions in public health, as carried out by Rush et al. (2004:1726), Brügger et al. (2004), Wanless (2004) or Drummond et al. (2008), but aims to present the main principles and procedures of CBAs of public health interventions according to the current state of the art and to report the main difficulties.

While the methodology of economic evaluations of health care treatments and programmes (e.g. drugs, medical procedures, screening programmes) is well established, economic evaluations of public health interventions differ substantially in their methodological approach. This difference is due to several aspects of interventions in public health:

1. It is harder to find out if an intervention works, or, in the words of Drummond et al. (2008), to *attribute outcomes to interventions*. Economic evaluations of health care measures are usually based on clinical effectiveness studies, such as randomised control trials (RCTs). However, few of these studies exist for public health interventions. Effectiveness is usually determined by statistical estimation based on non-experimental data, extracted from an environment in which many variables change contemporaneously. Economists have a methodological tradition of dealing with this type of data. Nevertheless, their results may vary considerably with the methods applied and the assumptions made by the single researcher.

[1] The WIG is part of the School of Management and Law of the Zurich University of Applied Sciences

[2] The time period considered will depend on the data availability.

2. It is more challenging to find out if an intervention is worth the effort and the money spent, because *public health interventions often have broader effects in the society and the economy*. A higher tax on alcoholic beverages will, for example, not only affect individuals with unhealthy drinking habits, but also those with healthy habits. The health care expenditures for the cure of diseases related to alcohol abuse may thus decrease, but also the drinking pleasure of the individuals with healthy drinking habits. The tax may also affect the number of accidents and crimes committed under the influence of alcohol, the productivity in workplaces and the business of restaurants and bars. When evaluating the costs and benefits of the tax the evaluators have to decide which of these many costs and benefits are to be considered and how they should value them in monetary terms.
3. It is harder to find out if an intervention is worth the effort and the money spent, because *it is particularly difficult to measure the improvement on quality of life*. The effect on health of prevention and health promotion interventions is often measurable only after a long time lag and with a considerable degree of uncertainty.

A further challenge in the economic evaluation of public health interventions by Drummond et al. (2008) is the issue of equity and the distribution of costs and benefits in a society, that is, how an intervention may lead to different gains and losses of welfare for different groups in the society. Although this issue appears to be very important, as even well meaning programmes may lead to increasing health inequalities, we will not discuss this issue in this brief review, because we will not be able to consider it in the current research project commissioned by the FOPH.

This report is based on a series of recent publications by organizations involved in the economic evaluation of public health interventions, apart from the already cited review by Drummond et al. (2008), in particular the *WHO Guide to Cost-Effectiveness Analysis* (WHO 2003) and the work of the *OECD Economics and Prevention Project* (Sassi and Hurst 2008).

The report is structured as follows: Section 2 gives an overview of current guidelines and recommendations for the economic evaluation of public health interventions. Section 3 presents the principal challenges encountered in measuring effectiveness of prevention and health promotion interventions. Section 4 contains a rough overview of the structure of CBA and Sections 5 to 7 develop the single steps of the CBA and illustrate difficulties and limitations. The main conclusions are drawn in section 8.

2 General guidelines for economic evaluation

General guidelines and recommendations for the economic evaluation of health treatments and programmes are a useful tool to improve the quality of research. Most of these guidelines, such as those presented by NICE (2004) or von der Schulenburg et al. (2008), focus on the evaluation of clinical studies but may also be helpful for economic evaluations of public health interventions.[3] General guidelines for observational studies have been developed by the STROBE Statement (STrengthening the Reporting of OBservational studies in Epidemiology) and are illustrated in von Elm et al. (2007).[4]

The checklist compiled by Drummond and Jefferson (1996) for the authors and peer reviewers of economic submissions to the British Medical Journal (BMJ) is particularly useful. We summarize its most relevant points with our comments in squared brackets [ ]. The entire checklist can be found in the appendix.

Study design:

- State the research question and its economic importance.
- State and justify the viewpoint or perspective of analysis. [in public health a societal perspective usually applies]
- State which alternatives are compared and why. [*no prevention or health promotion* is a typical alternative for prevention and health promotion interventions]
- State why the type of analysis is chosen to answer the research question.

Data collection

- State sources of effectiveness estimates, study design and result.
- State primary outcome measure for the economic evaluation.
- State methods to value health states.
- Report productivity changes separately and discuss their importance.
- Report quantities of resources and price data separately from their unit costs.
- Report details of models used and justify key parameters used in models.

Analysis and interpretation of results

- State time horizon.
- State and justify discount rate used.
- Report details of statistical tests.

[3] See Hjelmgren et al. (2001) for an overview and a comparison of health economic guidelines.

[4] See the website of the STROBE initiative (www.strobe-statement.org).

- Carry out and report sensitivity analysis and justify variables modified.
- Present major outcomes in aggregated and disaggregated form.
- Give the answer to the study question, with conclusions following from reported results.
- Accompany conclusions with appropriate caveats.

The recommendations of Drummond et al. (2008) for improving the evidence on cost-effectiveness in public health add some important points to the previous checklist. We summarize these recommendations, excluding the recommendations for further research. The entire checklist can be found in the appendix. For a short version of this list see PHR (2007).[5]

Attribution of outcomes

- Seek to conduct RCTs of public health interventions and extrapolate outcomes beyond the end of the trial.
- Use natural experiments and non-experimental data, when RCTs are not available.
- Use all relevant information available.
- Use advanced econometric methods.

Measuring and valuing outcomes

- Perform cost-consequences analysis prior to valuing outcomes.

Equity considerations

- Estimate the opportunity cost of not choosing the most cost-effective option, when this option is likely to be judged inequitable.

Intersectoral costs and comparisons

- Describe intersectoral impacts of public health interventions.
- Quantify intersectoral impacts in a cost-consequence analysis in a way that makes most sense in each sector.

[5] For a discussion of the challenges of economic evaluation in health promotion see also Godfrey (2001). For an easily accessible discussion of economic evaluation in health promotion see Hale et al. (2003)

3 Measuring effectiveness

The question of the effectiveness of an intervention is the question of whether the intervention *works* in reaching its goal and the question on the *size* of this effect. The study of effectiveness thus answers the *'Does it work?'* question. It has to be answered before examining the *'Is it worth it?'* question.

Studies on the effectiveness of interventions in the field of prevention and health promotion are rare, because the standard methods of medical research, such as RCTs, are seldom applied for practical, ethical reasons and because of limits in funding. However, an economic evaluation of an intervention is impossible without a prior assessment of its effectiveness. The economic evaluation of a public health intervention is thus frequently accompanied by an assessment of its effectiveness.

The measurement of effectiveness of public health measures is usually carried out with the help of non-experimental data (e.g. observational data on cigarette consumption) and data from natural experiments (e.g. observational data on cigarette consumption in two comparable cities with a different smoking regulation) obtained from a variety of sources (Drummond et al. 2008). The researcher builds a theoretical model, which includes a variable representing the health outcome of the intervention, a variable for the intervention and variables for all other factors potentially influencing the health outcome. The magnitude of the effect of the intervention on the outcome is estimated with a multivariate regression or another statistical technique and the aid of econometric software. These methods have long been used and continuously been improved in the field of economics, but the validity of the results depends on the quality of the data, the validity of the theoretical model used by the researcher and the appropriateness of the statistical method applied.

The main challenges encountered when measuring effectiveness in this context are illustrated in the following:

1. *Complexity and multi-component nature of prevention and health promotion measures*: It is difficult to identify the impact of specific variables while controlling for others (Abelson et al. 2003). The number of factors influencing the health outcome is usually high and their interaction not always straightforward. If we want to explain how changes of an intervention (e.g. a new law prohibiting smoking in public places) influences individual behaviour, we have to control for all other factors that may have changed at the same time (e.g. a change in public attitude regarding smoking) and are correlated with the intervention. In an econometric analysis with aggregate data on a national level we thus have to include all these explanatory factors. On a technical level this may lead to problems of multicollinearity, because of the inclusion of too many explanatory variables modelled as dummy variables contemporaneously change in the same way (see econometric textbooks as Wooldridge (2003) or Gujarati (2003) on the problem of multicollinearity).

Another aspect of the complexity is the possible impact of seemingly unrelated measures or spillover effects from other policy fields (Drummond et al. 2008): An alcohol prevention campaign might reduce road accidents and a smoking ban might increase obesity. Furthermore, there may be synergies between interventions, when combining two interventions they are more effective than what the single norms would be in sum.

Finally, prevention and health promotion efforts are often carried out contemporaneously by national, cantonal and communal institutions. This may facilitate the estimation of the effectiveness of some interventions, when an intervention is carried out in some cantons but not in others. However, this additional complexity may also represent an additional obstacle in measuring effectiveness as it is often very difficult to collect data on a regional level.

2. *Presence of trends:* If some of the explanatory factors have a trend, this trend will influence the intermediate and final outcome (Abelson et al. 2003). If a number of explanatory factors have a common trend, as when continuous safety improvements in road construction, steady innovations car safety and the progressive diffusion of a more health-conscious lifestyle all lead to a progressive reduction of fatal road accidents, it may be quite difficult to decompose the trend and thus quantify the impact of the single factors.
3. *Omitted variable bias:* Complexity means that in order to accurately assess the effect of prevention measures on the intermediate or final outcome we should control for all factors that also influence the outcome and are correlated with the prevention measures. But many of these factors might be unobservable (e.g. changes in social norms & values or improvement in road safety) and nevertheless be very important. Our result might thus be seriously biased if we do not consider them (Wooldridge 2003).
4. *Measurability of outcome:* According to famous quote of Albert Einstein *"Not everything that can be counted counts and not everything that counts can be counted"*. Economic evaluation is often concerned exclusively with the effects of an intervention on mortality and morbidity but the definition of health may be much broader, as the 1958 WHO definition of health as "a state of physical, mental and social well-being". Measuring the outcome of an intervention only in terms of reduced mortality and morbidity, because no measure of general well-being is available, may lead to underestimate the effectiveness of the intervention (Richardson 1998). This problem may also be seen as a version of the lamppost problem (*"I lost the keys in the ally but it is dark there so I'm looking under the lamppost"*) (McCloskey 1994).
5. *Time lags*: The efforts of prevention and health promotion may influence behaviour only with a certain delay and the here may be long time lags between changes in behaviour and changes in health (Abelson et al. 2003). These time lags represent an additional challenge for the estimation of effectiveness, as they

have to be defined in the econometric model and thus affect the way outcomes are attributed to interventions (Chevrou-Séverac and Wieser 2007). For obesity the time lag between a change in the urban environment and change of BMI in children might be quite long, because established habits have to change. For road accidents the corresponding time lag should be much shorter.

6. *Nature of relationship (intensity, functional form):* A change of preferences and restrictions due to prevention measures will not always lead to a change in behaviour. The health effect of an intervention may differ according to the intensity of or addiction to the risky behaviour (strong drinking, long-term smoking) or the coexistence of different risk factors (when somebody smokes *and* drinks). The relationship between intervention and behaviour and between behaviour and outcomes may also not be linear (Abelson et al. 2003). It might be necessary to reach a certain level of intensity of the prevention effort in order to trigger a change of behaviour (dose-response). If many people have same the trigger level there might be a strong change when this level reached.

   Furthermore, unhealthy behaviour does not always result in negative health effects. The relationship between a risk factor and final outcome may be non-linear, and the relationship between concurrent risk factors and final outcome are often interdependent, and may not be independently additive, see e.g. Manning et al. (1991).

7. *Context-analysis*: The intensity and form of the connection between intervention, individual behaviour and health outcome may differ among groups of individuals. The connection may differ with respect to gender, age, etc. of the participant and with the setting of the intervention (school, family, workplace, community) and the source of delivery. The relation might also be influenced by social herd effects, when people imitate each others behaviour.

8. *Intermediate and final outcomes:* The effect of a prevention effort can be measured at different steps of the causal path leading to the final health outcome. Changes of individual preferences, health literacy and behaviour as well as physical effects (e.g. BMI, blood pressure) may be seen as intermediate outcomes while health state, life expectancy and quality of life are the final outcomes.

   Sometimes it might be easier or more useful to measure the effect of a prevention effort on a change of awareness than on a change of behaviour or a change of the prevalence of the related diseases. But it might also be the case that the change of behaviour is only temporary and thus there is no effect on health (imperfect sustainability). The ideal outcome indicator(s) used in effectiveness measurement depends on the research aim and perspective.

9. *Public health's broad definition of benefits:* Prevention and health promotion may call for a broader definition of outcomes and benefits than many clinical efforts that aim at eliminating existing adverse health states. Public health efforts often

aim at more than just one public health topic and hence may impact on more than one health-relevant aspect. For example, an alcohol prevention measure may reduce alcohol prevalence and thus reduce morbidity, mortality and loss of quality of life of the affected. Also, it may increase the quality of life of family members. Likewise, an obesity prevention program not only aims at reducing obesity prevalence but may also intend to increase physical activity independent from body weight, social cohesion and support in a community, psychological wellbeing, etc. In addition to the targeted effects public health efforts may cause positive and negative side effects and inter-sectoral effects (smoking and drinking, drinking and road accidents, smoking and obesity) (Manning et al. 1991).

10. *Role of the health system*: The health system may influence the outcome on the causal path from the factors influencing behaviour to the health outcomes with primary, secondary and tertiary prevention and treatment. It influences preferences and raises awareness via medical knowledge (doctor's advice) and poses restrictions (there is no HIV vaccine), it can directly influence behaviour (stop smoking therapies), reduce the adverse effect of the consequences of unhealthy behaviour (blood pressure drugs) and reduce the severity of the consequences of consequent diseases (therapies for diabetics, emergency surgery for victims of road accidents). The possible influence of the health system must thus be considered when estimating effectiveness.

4 Framework of cost-benefit analysis

In order to find out whether an intervention is worth the effort and the money spent, its costs have to be compared with its consequences – and this is the task of economic evaluation, which thus provides the answer to the *'Is it worth it?'* question.[6]

Costs are the monetary valuations of resource inputs required to produce a health outcome. Consequences are the health outcomes and the resources saved thank to the intervention (Luce and Elixhauser 1990:2; Drummond et al. 2005:19).

Table 1 shows the main forms of economic evaluations according to Drummond et al. (2008:19). They differ in the way they measure the consequences of an intervention as the costs are always measured in monetary terms.

The advantage of cost-effectiveness analysis (CEA) of measuring consequences in natural units of one determinate form (e.g. in life years gained *or* cases of adiposity prevented) is its simplicity and ease of interpretation. The main drawback is that only one consequence is measured and the analysis will be somewhat incomplete if more than one consequence is relevant.

Cost-consequences analysis (CCA) measures consequences in natural units as CEA, but may include more than one consequence (e.g. in life years gained *and* cases of adiposity prevented). The drawbacks are that results cannot be summed to a single figure and that it is difficult to compare the results among fields of prevention.[7]

Table 1: Types of economic evaluation

	measure of cost	measure of consequences
cost-effectiveness analysis (CEA)	money	natural units of one kind (e.g. life years gained ***or*** cases averted)
cost-consequence analysis (CCA)	money	natural units of many kinds (e.g. life years gained ***and*** cases averted)
cost-utility analysis (CUA)	money	health status (e.g. quality adjusted life years gained QALY)
cost-benefit analysis (CBA)	money	money
		adopted from Drummond et al. (2008)

[6] See Shiell et al. (2002) for a brief introduction into the concepts and terms of economic evaluation in health.

[7] See Kelly et al. (2005) for a discussion of the differences between CCA and CEA.

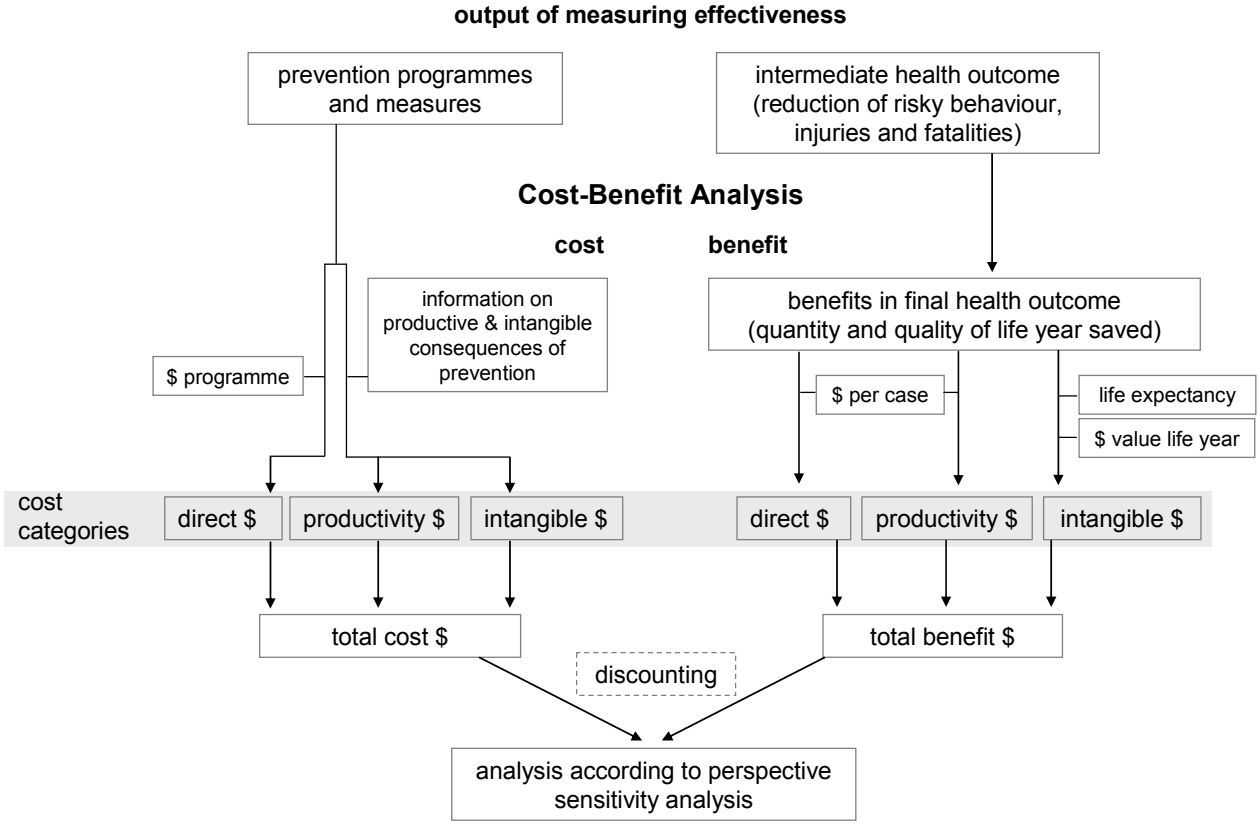
In cost-utility analysis (CUA) the health consequences in terms of life expectancy and quality of life are combined to a single figure by attaching utility weights to single health states to calculate health-adjusted years of life saved. Consequences of health promotion efforts can thus be compared between different fields.

In cost-benefit analysis (CBA) the utilities gained are transformed into a monetary value and can thus be directly compared with its costs. It is then possible to calculate the return of an investment in prevention or health promotion. In a broad evaluation of the consequences of an intervention, which includes all sorts of costs (e.g. increased commuting times due to lower speed limits) and of consequences (e.g. a decrease of absence from workplaces). However, CBAs hinge on the requirements regarding methodological solutions to value intangible effects in monetary terms.

CBAs are widely used in other fields such as environmental economics or transport economics. As the computation of the consequences of an intervention in terms of gains in natural units (e.g. life years) and in terms of gains in utility (e.g. QALYs) is required for a CBA, the CBA includes a CCA and a CUA.

Figure 1 gives a rough overview of the framework of CBA. Both cost and benefits are based on the results of the previous measurement of effectiveness and both require the input of further information in order to compute total costs and total benefits.

Figure 1: Framework of CBA



Tasks on the cost side:

- Assess the direct costs of the prevention programmes (programme costs, administrative cost of prevention agencies).
- Assess possible productivity costs (e.g. longer business travel time due to a lower speed limit introduced for the prevention of road accidents).
- Assess possible intangible consumer's welfare losses due to prevention (e.g. loss of the pleasure of smoking in night clubs due to a smoking ban)

The tasks on the benefit side are more complex. The main challenge is the valuation of the consequences. Benefits are mainly represented by avoided costs (i.e. resources saved) that would have occurred without the successful prevention and health promotion effort.[8] Cost categories include direct costs (e.g. health care expenditures), productivity costs (e.g. reduced production due to absence from workplace), and intangible costs (e.g. lost quality of life). In addition, these cost categories can be split into internal costs (e.g. only those affecting smokers themselves) and external costs (e.g. only those affecting passive smokers).

Step by step, a CBA thus comprises the following tasks on the benefit side:

- Transform the intermediate health outcome assessed (reduced morbidity and mortality) into final health outcomes, i.e. health-related life years saved. This task requires the information on life expectancy and a monetary value for a life year.
- Calculate intangible costs avoided by transforming the health-related life years gained into a monetary value.
- Calculate direct costs avoided.
- Calculate productivity costs avoided.
- Calculate external costs avoided. External costs include only costs caused to others by sovereign consumers and not the costs they inflicted on themselves.

The final task will be the comparison of costs and benefits, and this will include the following tasks.

- Discount past and future costs and benefits to the reference year.
- Carry out a sensitivity analysis.

[8] Parts of the benefits (e.g. the gain in quality of life) may not be regarded as avoided costs by non-economists. If the prevention measure, however, had not been implemented, the individual would have had a lower quality of life due to illness or injury. In a CBA, this loss in quality of life is converted into money and counts as a cost attributable to the illness or injury. Since the prevention effort has successfully avoided the illness or injury, it has also avoided this cost.

5 Cost side

The cost side of a CBA of prevention and health promotion measures may include the following cost categories (Torrance 1986):

1. Direct costs
2. Productivity costs
3. Intangible costs

Direct programme costs include resource use associated with planning, implementing, monitoring and administrating a prevention programme (Johns et al. 2003). Most of these costs are borne by the agency organizing the programme, which usually is financed by the government respectively the tax payer. However, some of the direct costs associated with a programme may also be borne directly by the households or private businesses (e.g. additional security devices for cars, additional labels on groceries). The government or uninvolved bystanders may also bear further direct costs arising from the criminalisation of certain behaviours (e.g. police interventions due to 'provision-related' crime, when buying alcohol is prohibited for underage kids or cigarettes are smuggled due to high taxes) and compensating or displaced behaviour (e.g. when people who stop smoking switch to other "vices", such as eating too much, or cycle less when obliged to wear helmets).

A practical issue in the determination of programme costs is often due to the fact, that the boundaries between public health programmes and other government actions are often blurred and that the nature of these programmes is often imprecise. Furthermore, some public health programmes may be administered outside of national health agencies and different levels of government (national, regional, local) may be involved. (Abelson et al. 2003)

Productivity costs (formerly often termed as *indirect costs*) correspond to lost production associated with the intervention. In the field of road accident prevention a lower maximum speed limit might for example lead to longer travel times and thus to a loss of productivity in the transport business.

Intangible programme costs are suffering and utility losses in general, that are associated with the intervention. An example is the sacrifice of pleasure that was formerly (i.e. before the prevention programme) deducted from smoking, eating fatty foods, drinking alcohol, etc. These intangible costs are particularly important when an intervention aims at the whole population and the behaviour is harmful only if consumption is above a certain threshold, as in the case of alcohol or sugar-sweetened beverages. A tax on these products or a restriction of their availability (e.g. by ban of vending machines) will lead to utility losses in all those individuals who would have experienced no negative health effect from the consumption of these goods.

But also many of those who will suffer negative health consequences from their consumption habits will claim to be negatively affected by an intervention limiting these

habits. They may claim that they are well aware of the negative health consequences, but that it is their free decision to sacrifice a part of their present and future health for the rare pleasures of life. The prevention and health promotion efforts are seen as a limitation of personal freedom due to the ‘paternalism’ of the government and the health authorities. This claim will be discussed in section 6.1 in the context of externalities, but some of these individuals may (at least in the long run) benefit from a restriction of choice because their decisions are distorted in the first place and the regulation helps them to align their decisions with their “true intentions”. Decisions may be distorted due to several reasons, among them are the following:

- Rationality may be bounded because the individual is present-biased, they discount too heavily or inconsistently. What occurs in the future is of disproportionate less significance to these individuals than what happens today.
- Lack of proper information regarding risks and consequences of certain behaviour. This can essentially be described as a health literacy problem.
- Willpower may be “in short supply” as some people may not stick to decisions they make and self-control may be low. (Schelling 1986)

Hence, the only effect of regulation to these individuals are costs that have to be borne, and apart from the direct costs such as higher prices paid for unhealthy goods in the case of taxes, the costs are mostly intangible, such as the limited freedom to choose in the case of bans and the like.

However, the costs (as welfare losses) caused by the programme are programme costs that should be accounted for in a comprehensive economic evaluation. Whether all of these direct, productivity, and intangible consequences of a prevention programme will in fact be quantifiable and valued in monetary terms is a different decision. Certainly, the impartiality of the evaluation will benefit when these consequences are accounted for at least qualitatively. As a general rule, researchers should begin an evaluation by enumerating the full range of observed or expected consequences that accrue from a prevention programme (costs and benefits).

6 Benefit side

6.1 Categories of benefits

The benefits of prevention arise from the avoidance of costs due to unhealthy or unsafe behaviours. As shown in figure 2 these cost categories may partially overlap and thus cannot be simply summed up (see Drummond et al. (2005) for a detailed discussion of costs categories in economic evaluations).

Direct costs include the cost of medical services, non medical assistance, administrative costs (health insurance, public administration), and material damage.

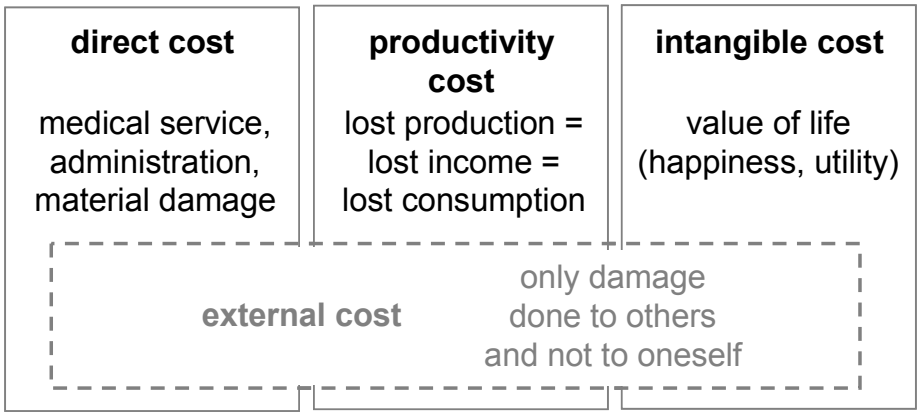
Productivity costs correspond to the monetary value of lost production potential (i.e. time) that results from mortality or from impairment in the health status and resulting absenteeism, productivity losses while on the job, and permanent disability. They may also include the replacement cost for a worker lost due to death or invalidity (hiring, training, initially lower productivity of substitutive labour).

Intangible costs are due to the loss value of life in itself (utility, happiness and enjoyment of life) due to the consequences of an unhealthy or unsafe behaviour. The calculation of these costs is discussed in detail in section 6.2 and 6.3.

External costs arise when harmful habits affect uninvolved bystanders. A reduction in the prevalence of smoking that may be traced back to prevention programmes not only yields benefits among the 'persons averted to be smokers' but also among all those individuals around that would have, without the prevention programme, been exposed to passive smoking. The costs suffered by the victims of crimes conducted under the influence of alcohol are a further example.

External costs may include direct, productivity and intangible costs but refer only to the costs caused to others and not to oneself. They thus represent a fraction of total costs caused by an unhealthy behaviour.

Figure 2: Overlap of cost categories on the benefit side



Internal costs are the costs that accrue to the individuals with unhealthy habits due to their own unhealthy habits.[9]

The distinction between external and internal cost is emphasized by economists (Manning et al. 1991; Sassi and Hurst 2008) and many of them believe that prevention measures are only justified if they contribute to the elimination of externalities (see for example Chaloupka and Warner (2000), Kenkel (2000) or Breyer et al. (2005)). Externalities are sometimes also subsumed under the term of spillover effects, which may be particularly strong for public health interventions because they affect many people who are not ill and because encouraging healthier lifestyles confer benefits beyond the immediate impact on health (Drummond et al. 2008).

Manning et al. (1991) make a further distinction in external costs: Cost in collectively financed programs, which occur when people with unhealthy habits use more public health services and pay less of the taxes necessary to finance these services, and immediate costs, which occur when people with unhealthy und unsafe behaviour have a negative impact on the well-being of bystanders.

There is a potential problem of double counting when summing productivity cost and intangible cost. The value of a life and thus life quality may in some measure be reflected in earnings. In fact, increases in health-related quality of life are often mirrored to some part in earnings (i.e. productive activity), and vice versa. It is therefore sometimes argued that accounting for changes in health per se (intangible costs) and for changes in productive output (productivity costs) in an economic evaluation is essentially double counting. If the value of improved health estimated in a given study already includes the value of the increased productivity that would result (using that improved health), then it would not be appropriate to include an additional estimate of the value of this item (Drummond et al. 2005:86). The Washington Panel, for example, therefore advises against including productivity costs explicitly (apart from the ‚extra friction costs', confined to replacement costs such as training costs or if substitutive labour is never quite as productive as the labour it replaces and the difference is not already captured by wage rates), and recommends incorporating averted productivity losses as health effects measured in quality of life measurement (Gold 1996:181).

Brouwer et al. (1997a; 1997b) oppose to the recommendation of the Washington Panel. They argue that accounting for changes in productive output only implicitly (i.e. to the extent that they creep into health-related quality of life assessment) does not lead to an accurate estimation of the productivity costs from a societal point of view. In particular, they argue that only health related effects on quality of life that cannot be straightforwardly monetarized should be considered as health effects.

[9] People with unhealthy habits bear some of the cost directly. “They lose wages, pay a portion of their medical costs, and suffer from disability and premature death. These are what we define as internal costs.” (Manning et al. 1991)

Given the controversy surrounding the inclusion of productivity changes Drummond et al. suggest to report productivity changes separately so that the decision-maker can make a decision on whether or not to include them (Drummond et al. 2005:87). Moreover, given the controversy with respect to the estimation of productivity changes, it is suggested to thoroughly consider whether earnings adequately reflect the value of lost production at the margin and whether an approach based on the adjustments necessary to restore productivity (for example, the friction cost approach) would be more valid, and to pay attention to the equity implications of the inclusion of productivity changes.

As in the case of programme costs, the problem arises how to quantify all effects. Here too, it is important to enumerate all effects in an appraisal, however intangible they may be.

A controversial issue and unresolved debate is the question whether to account for potentially increased health care expenditures because of longer life expectancy. These costs are called future unrelated medical costs, i.e. medical costs that occur due to treatment of other diseases during added years of life; as opposed to future related medical costs, that occur due to the treatment of the investigated disease during added years of life. The WHO Guide (Tan-Torres Edejer et al. 2003) suggests to exclude these costs from economic evaluation.

6.2 Measuring benefits in terms of final health outcome

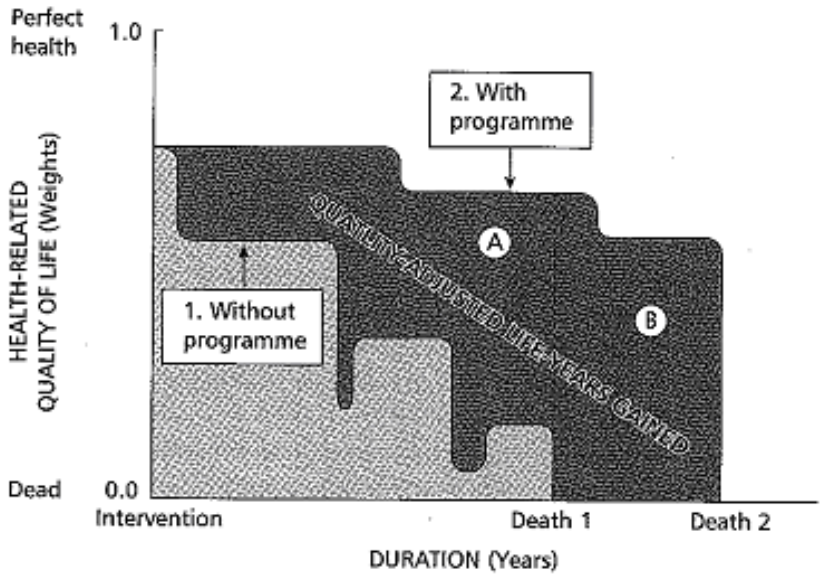
In order to measure the benefits of the prevention programmes it is necessary to transform from the intermediate outcome variable to the final health outcome, measured in disability-adjusted life years (DALYs), quality-adjusted life years (QALYs), or some other measurement of health related quality of life (HRQoL).

The final health outcome of interest in a CBA combines (1) a measure of life expectancy with (2) a measure of life quality that weights the health states which will be experienced during the expected duration of life (Dolan 2000:1729), where life quality is defined as the social, physiological, mental, intellectual, and general well-being of individuals (Luce and Elixhauser 1990:153). The HRQoL weights are adjustment factors for utilities, and reflect the relative desirability of each health state. They are usually expressed on a scale that ranges from 1=perfect health to 0=death. Combining the HRQoL weights with the life expectancy gives equivalents of years of life lived in good health.

The final health outcome is a health *profile*, a sequence of states of health, and not a single health state. Health programmes will differ with respect to the different states of health that an individual might be in and the different lengths of time spent in each state, as illustrated in figure 3.

The quantity of life gains (survival or reduced mortality; part B in figure 3) and the HRQoL improvement (i.e. the gains from reduced morbidity or quality gains; part A in figure 3) experienced by individuals in response to a health care programme or a change in lifestyle are combined into a single metric by multiplying (i.e. weighting) the duration of each health state with the HRQoL of each health state. Thus, interventions can generate health gains by lengthening life or improving its quality.

Figure 3: Health profile



Source: Figure 6.6, extracted from Drummond et al. (2005:173)

To operationalize this concept, one needs data on

1. the sequence (and probabilities) of possible health states given a certain treatment or lifestyle,
2. the expected duration spent in a given health state, and
3. the quality weights that represent the HRQoL of the health states under consideration. These quality weights are the scale for the vertical axis in the graphic illustration of a health profile.

While the first two data requirements are relatively straight-forward, in the assessment of quality weights, one has to choose between different concepts of HRQoL, the two most prominent of which are the QALYs and the DALYs.

6.2.1 QALYs

The most prevalent and traditional measure advocated by health economists is the quality-adjusted life year QALY. The concept was introduced in the early 1970s and remains fundamentally unchanged 35 years later, and has gained tremendously in popularity over time (Sassi and Hurst 2008:48).

The QALY approach involves a number of assumptions and limitations. Among these assumptions are the following (see for example Breyer et al. (2005:27ff) for an overview):

1. QALYs are equal, regardless of who gains them.
2. The relative weights for health states are independent of the duration of those states (so called utility independence between life years and health status).
3. The preferences individuals have for paths of changing health states can be reasonably estimated by adding up the time-weighted preferences the individual has for the components of the path (so called additive separability).
4. The preferences for health states are stable over the entire life time.
5. There is risk neutrality over life years, i.e. individuals are neutral towards gambles on life years and health status.
6. Preferences either fulfil the zero condition (that all health states are regarded as equivalent if there is no remaining life time) or are characterized by a constant proportional trade-off. A constant proportional trade-off means that the proportion of life years an individual would sacrifice for a HRQoL improvement is independent of the remaining life time.
7. Preference or utility for a health state are independent of other factors apart from health that commonly influence utility, such as consumption, disposable income, etc. Only then can QALYs be interpreted as an interpersonal health index.

The QALY concept is not without controversy. In fact, *"the critics range from those who argue that the QALY approach is needlessly complex and should be replaced by simpler disaggregated measures to those who claim that the QALY approach is overly simplistic and should be replaced by more complex methods"* (Drummond et al. 2005:178). The fact that QALYs are preference-based and grounded on economics' utility framework makes them an appealing choice for a HRQoL weight. After all, determining how illness or treatment affects desirability of life is a matter of preference or utility. A drawback of QALYs are the (many) strong assumptions and limitations of the concept as illustrated above. Empirical research indicates that in general, the assumptions of the QALY model are not fulfilled (Breyer et al. 2005).

6.2.2 DALYs

The health gap measure DALY was developed by the World Health Organization for the Global Burden of Disease Project. It has been developed in order to calculate the loss, expressed in terms of years of life in full health, associated with premature mortality and morbidity. Thus, DALYs measure the difference between a specific health state due to a disease and a state of perfect health. Insofar, it is a measure of utility or preference for a specific health state, such as QALY. Major differences exist, though, between DALYs and QALYs:

- DALY weights are based on experts' judgements (a panel of health care providers) that represent social preferences, whereas QALY are based on individual preferences. Therefore, QALYs and DALYs differ to the extent that *"[…] QALYs measure health outcomes in terms of gains in health as compared to DALYs which measure them as losses from normative benchmark"* (Dolan 2000:1726).
- DALYs are disease-specific measures, whereas QALYs are generic health descriptions. Although measured on similar scales, the QALYs represent levels of quality of life enjoyed by individuals in particular health states, while DALYs represent levels of loss of functioning caused by diseases.
- A further distinction relates to the assumption of the QALY concept that a QALY is a QALY regardless of who accrues the health gains (the first assumption of the QALY-concept as illustrated above). DALYs change the assumption that all health gains are equal by weighting on the basis of age. DALYs apply unequal weights to health gains based on the age of the recipient. This age-weighting function assigns different weights to life years lived at different ages. For example, a life year gained when a person is 25 years of age is assigned a higher value than when the person is younger or older. These weights were selected to capture social roles at different ages.

With respect to the different HRQoL weight elicitation method it is often argued that a question regarding the preference valuation of a health state can only be answered by individuals affected by the health state. The expert's competence is rather with respect to technical aspects of health and not so much of utility aspects. Since the

DALY-concept is based on expert opinion it is thus not the ideal basis for decisions (Breyer et al. 2005:25). A big advantage of the DALY-concept is that these standardized weights are already available for research and thereby facilitate cross-country comparisons of economic evaluation results. Moreover, WHO-CHOICE employs DALYs in its CEA, and they recommend that other analysts also use DALYs for purposes of comparability (Tan-Torres Edejer et al. 2003:50).

With respect to DALY weights being disease-specific, there is the advantage that DALYs can be summed up in the case of comorbidities, as opposed to QALYs which are generic health descriptions and thus do not necessarily draw a strict line between comorbidities (Dolan 2000:1726). In QALYs the disutility associated with a health state may reflect co-existing health conditions or risk factors that predispose to the disease rather than the disease itself. If treatment does not remedy these associated (or even un-associated) health conditions, quality of life cannot be improved as greatly as would be predicted according to the HRQoL.

6.2.3 Source of quantitative HRQoL values

For use in an economic evaluation, HRQoL values related to a specific health state need to be quantified. Basically there are three possible sources to determine the utility values: the values can be estimated (1) using judgement, (2) they can be drawn from suitable published literature, or (3) they can be measured (Torrance 1986:8).

1. The researcher or experts can give point estimates or a range of plausible values for the HRQoL. Due to its feeble empirical foundation, extensive sensitivity analysis should be undertaken when utility values from judgements are used. Values obtained from judgements *"[…] may be sufficient, if the sensitivity analysis shows that the conclusions are relatively insensitive to wide changes in the utility values. […] However, if the analysis shows that the results are sensitive to utility values, one would want to obtain utilities that are more credible, either from the literature or by measurement"* (Torrance 1986:9). The judgement approach has the advantage of being quick and inexpensive.
2. When values are drawn from the published literature it is important to ascertain that the source is appropriate to the currently conducted research study with respect to health states, subjects used in the measurement, and the measurement instruments used (Torrance 1986:9).
3. Measuring HRQoL values involves the identification of health states for which utilities are required, the preparation of health state descriptions, the selection of subjects, and the use of a utility measurement instrument. It is generally seen as the most appropriate alternative (Torrance 1986:10).

6.3 Valuing benefits in monetary terms

Placing a monetary value on improvements of health states is perhaps the most challenging and ethically controversial step when valuing benefits in monetary terms (Garber 2000). The challenge is that essentially immaterial aspects of life, such as life expectancy, quality of life, and psychosocial consequences such as pain, anxiety, job changes, etc. need to be valued in monetary terms. DALYs and QALYs incorporate aspects of life expectancy and of quality of life and hence reflect all these intangible, immaterial consequences. Thus, the monetary value of changes in health states is obtained by multiplying the QALY- or DALY-gains with the value of a statistical year of life.

Alternatively the improvements of health states may also be valued directly with a willingness-to-pay approach described in this section without passing through the intermediate step of calculating HRQoL.

The difficulty of the task at hand and the controversy of the intention itself are mirrored in the large ranges of variation of results in the empirical research of the monetary valuation of a statistical life year. There are, however also some clearly identifiable patterns, especially by valuation approach, individual characteristics, or characteristics of health risks (Sassi and Hurst 2008:49). An established literature exists on the assessment of the monetary value of a statistical life year and health improvements.

There are two main general approaches to the monetary valuation of health outcomes:

1. *Human Capital (HC) approach* is based on the concept of health as a component of human capital. In this view, health is a factor enabling active production and participation in the economy. Accordingly, the monetary value of health is equivalent to the market value of an individual's production, i.e. the discounted value of the individual's earnings. This value is calculated by multiplying time lost for productive activity due to premature mortality or impaired health due to morbidity by earnings.

   The valuation method of the human capital approach is criticized to be not consistent with the principles of welfare economics because it offers a narrow view of the utility consequences of a programme by restricting to impacts on labour productivity. The HC approach will typically yield lower values for health than the willingness-to-pay (WTP) approach because the WTP at least theoretically takes into account a broader array of benefits than does the HC approach. The WTP is preferred conceptually to the HC approach by many economists. Moreover, it implicitly assumes that the health of individuals who are less able to participate in economic production (e.g. the elderly, the disabled) has no monetary value.

   There are two uses for the HC approach: (1) as the sole basis for valuing all aspects of health improvements, and (2) as a method of valuing part of the benefits

of health care interventions, using earnings data as a means of valuing productivity changes only (Drummond et al. 2005:215). Thus, even if the human capital approach is not deemed suitable for valuing health per se, the aspects it typically measures, namely the contributions to economic production, represent important components of the impact of prevention programmes and should not be neglected.

2. The *WTP method* elicits values which individuals would be willing to spend to stay alive and healthy (or keep other people alive and healthy) compared to being in a specific undesirable health state. It is founded on the premise that, given that health is an important (but not the only) argument in an individual's utility function, it is possible to estimate the welfare change associated with a change in health if we can determine the compensating change in one of the remaining arguments in an individual's utility function that leaves utility unchanged (Dolan 2000:1733). The WTP method aims to determine the change in income or wealth that is necessary to compensate an individual for a change in health so that utility for the individual remains unchanged. The thereby elicited amount is the maximum amount the individual is willing to pay for an improvement of health, and reflects the utility or benefit of the health improvement in monetary terms.

   The WTP method uses *Stated Preference* (SP) or *Revealed Preference* (RP) approaches.

   The *SP approach* involves a survey of a group of individuals in which a series of questions are asked aimed at eliciting the amounts respondents are willing to pay in order to obtain a certain good or service, or to enjoy the outcomes expected from the consumption of that good or service. The substantial variation in results and the inconsistency encountered in the answers to hypothetical questions reflect the doubts regarding the reliability of the SP method (Breyer et al. 2005:58). Some consistent patterns across answers have also been observed, namely that individuals with a higher disposable income or wealth report a higher willingness to pay, and the more services are offered in a health programme (i.e. quantity), the higher is the individuals' willingness to pay for the programme.

   The *RP approach* is based on decisions made within market settings. The idea is to deduct the willingness to pay from the observed market behaviour of individuals. This provides opportunities to establish a link between aspects of health and monetary values. A common example of this approach is the assessment of wage/risk tradeoffs in labour markets, involving the estimation of the wage premium offered in return for the acceptance of health risks by employees. The strength this approach is that it is based on actual consumer choices involving health versus money, rather than hypothetical scenarios and preference statements. However, the RP approach also has a number of methodological drawbacks which limit its application. Among those is the almost impossible separation

of willingness-to-pay for a reduction in the health risk from other influencing factors in observational data.

In analogy to the source for the HRQoL weight, estimates for the monetary value of a health improvement (in terms of an additional year of perfect health) can be determined

1. by using judgement,
2. by selecting from the published literature or
3. by measurement.

The discussion of the methods for assessing the value of health in the previous section shows that measuring this value is a highly elaborate and time-consuming task which does not seem be a feasible option for our CBA of prevention and health promotion in Switzerland.

The most feasible alternative is to extract this value from published literature. Hirth et al. (2000) and Viscusi and Aldy (2003) give a very useful overview of the body of research that has estimated the value of a life. On the basis of these two literature sources we suggest generating a baseline estimate of the value of a QALY and upper and lower bounds on this value for use in sensitivity analysis.

7 Comparing cost with benefits

7.1 Discounting future costs and benefits

When costs or consequences do not occur within a relatively short time frame or simultaneously, the results of the evaluation should be adjusted to reflect positive time preference. Positive time preference means that costs and consequences incurred in the present have greater value than those which occur in the future.

While it may appear logical to discount costs, the thought of discounting non-economic values such as a year of life saved may appear questionable. After all, this implies that a year of healthy life in the future is valued at less than a healthy year now. Failure to discount consequences, however, can lead to illogical conclusions. If future costs are discounted but future consequences are not, then it would be possible to conclude that health programs should be postponed indefinitely because they will have lower future costs for the benefits that are equivalent to those experienced today (Luce and Elixhauser 1990).

Not only due to this fact, has the majority recommended discounting should be conducted for both sides in evaluations.

The rate chosen is important, however, especially when the programme analysed has predicted cost savings or benefits that occur well into the future and for alternatives having different patterns of cost and consequence over time. The higher the discount rate, the less value is placed on costs or consequences that are incurred farther in the future. Thus, for prevention programmes whose costs are immediate while benefits are not expected to accrue for many years, a high discount rate would diminish the net benefits of the program.

Discount rates are based either on the real rate of return to society forgone in the private sector (known as the social opportunity cost approach) or the social rate of time preference. They generally take a value between 3% and 5%. However there is a Swiss norm to use a discount rate of only 2% in CBAs in the field of road accidents (VSS 2006). The choice of the discount rate should be subject to sensitivity analysis. Usually the rate is therein extended to the range of 0% to 7% (Abelson et al. 2003:13; Tan-Torres Edejer et al. 2003:71; Drummond et al. 2005:76f., 111)

7.2 Sensitivity analysis

Evaluations normally include information which is subject to uncertainty. Sensitivity analysis is a vital tool which can assess how important these areas of uncertainty are and whether different assumptions or estimates would produce substantially different results and conclusions (whether the results are sensitive to assumptions made) (Briggs et al. 1994; Briggs 2004). If the conclusions drawn from the study do not change as these values are altered, the results of the analysis are robust to changes in this variable.

Since uncertainty is present in every step in a CBA, the sensitivity has to be analysed in every step, i.e. when specifying the empirical model and conducting the effectiveness analysis for intermediate health outcomes, when translating this into final health outcomes, when valuing benefits in monetary terms, when assessing costs, and when discounting.

According to Drummond et al. (2005), consideration of three topics applies whenever conducting a sensitivity analysis:

1. Identifying the uncertain parameters

   There are no guidelines which would specify which parameters should be analysed. It is much easier to identify those variables, which are presumably certain and can therefore reasonably be excluded.

   Consequently, the parameters to be included in the analysis will be different for each study. In the face of consistency there are nevertheless some parameters, which will be found in every CBA. Among those are the “effectiveness parameter“(i.e. the coefficient estimated by econometric analysis proving the effectiveness of the intervention), discount rate, the value of a statistical life (year) and of a QALY/DALY for different health states or the problem with overlapping cost items and double counting (productivity and intangible costs, see page 20).

2. Specifying the plausible extent of variation

   Once the parameters are identified, the next step is to specify the plausible extent of variation. Popular ranges are specified confidence intervals, (supposed) minimum and maximum values and the rather arbitrary doubling or halving the value.

   In doing so it is crucial, albeit unfortunately often left out, to justify the chosen range. Reviewing the literature and consulting advice from experts are ways to find reasonable ranges.

3. There are several methods to conduct a sensitivity analysis :

   – The most widely used method is the one-way analysis due to its simplicity. This is some kind of a *ceteris paribus analysis*, where only one of the uncertain parameters is varied to examine the effect on the study results, while the

others are held constant. But because most of the parameters interact with each other, this is a serious drawback of this method.

- In order to avoid this problem a *multi-way analysis* can be performed. Here, those parameters whose mutual interaction is known are to be varied simultaneously. However, since those interactions are manifold and often include several variables, this approach is fairly challenging.
- Another common method is *scenario analysis*. Different scenarios can be determined, although usually a best guess (or base case), a least conservative (high for benefits, low for costs) estimate (best case), and a most conservative estimate (worst case) are applied.
- Moreover, particularly critical parameters could be subject to a *threshold analysis*. Thereby a specific threshold is defined (e.g. break-even point) above or below it is either worth to implement a new programme or continue to support it or not. The parameters could then be estimated so that they exceed or fall below the threshold. Hence, the decision how likely it is that the parameters take on those certain values is left to the public or decision maker.
- An alternative approach, provided the parameters are stochastic, would be to undertake a probabilistic sensitivity analysis. The *Monte Carlo approach* reproduces the distributions of the relative likelihoods of particular values of the parameter.

8 Conclusions

Does it work? Is it worth it? This short review of the current literature on economic evaluations in the fields of health promotion and prevention has shown the complexity and the multitude of open issues to be considered when answering these questions.

Does it work? The assessment of effectiveness is a highly challenging question for public health interventions, because effectiveness can rarely be assessed through RCTs but must be determined by statistical estimation based on non-experimental data. The assignment of outcomes to interventions must consider the complexity and multi-component nature of prevention measures and a number of technical difficulties (e.g. presence of trends, time lags, functional form). Careful modelling and advanced econometric techniques are the appropriate tools to tackle these challenges.

Is it worth it? The CBA of measures in health promotion and prevention is complicated by the broad effects they may have in the society and the economy (e.g. externalities and productivity changes) and by the difficulties in measuring and valuing the improvements of quality of life. A CBA will usually comprise a CCA and a CUA, as the health effects of the intervention are measured in natural units and will be first transformed into HRQoL years and then valued in monetary terms.

The discussion among economists and public health experts is still open on many issues. It is thus essential to clearly state and justify the study design and to follow established guidelines, where they can be applied. Furthermore, costs and benefits accounted for should be clearly reported and justified. Results should include an extensive sensitivity analysis, discuss the main limitations of the study and clearly convey the principal conclusions for health promotion and prevention policies.

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Glossary[10]

Absenteeism	Absence from work as due to disease or accident
Bias	Lack of objectivity or randomness resulting in an imbalance that makes it likely that the outcome will tend to be distorted. Some possible sources of bias: interviewer bias; non-response bias; prejudice; sample selection bias; sampling error.
Contingent valuation	Method of placing a monetary value on an item or service that is not available in the marketplace by determining – contingent on it being available in the marketplace – the maximum amount people would be willing to pay for it (buying price) and/or the minimum amount people would be willing to accept to part with it (selling price).
Cost-consequence analysis (CCA)	Economic evaluation reporting the costs of an intervention and the outcome in term of natural entities as life years saved or number of cases prevented.
Cost-utility analysis	Economic evaluation reporting the costs of an intervention and the outcome in term of healthy years typically measured as QALYs or DALYs.
Direct cost	Cost of resources used to deal with the consequences of disease or accident. They usually include costs of health care (covered by health insurance, public health care system and out-of-pocket expenses), assistance to individuals affected (e.g. transport, activities of daily living) and may also comprise administrative costs and material damage.
Disability-adjusted life years (DALYs)	Indicator developed to assess the global burden of disease. DALYs are computed by adjusting age-specific life expectancy for loss of healthy life due to disability. The value of a year of life at each age is weighted, as are health decrements from disability from specified diseases and injuries.
Dose response	Indication of how an individual, or a population, is likely to be affected by a change in the amount, intensity, or duration of an exposure.
External cost	see *externalities*
Externality	A cost or benefit arising from any activity which does not accrue to the person or organization carrying on the activity; also called 'spillover effects'. Example of negative externality: Health damage inflicted to non-smokers by smokers.

[10] Partially based on Black (2002), Drummond et al. (2005), Drummond et al. (2008), Wikipedia.org, www.oxfordreference.com

Functional status	Individual's effective performance of or ability to perform roles, tasks, or activities (e.g., to work, play, keep house). Often functional status is divided into physical, emotional, mental, and social domains, although finer distinctions are possible.
Health state	Health of an individual at any particular point in time. A health state may be modified by the impairments, functional states, perceptions, and social opportunities that are influenced by disease, injury, treatment, or health policy.
Health status measures	Instrument that describes the health status of a person in each of a comprehensive set of domains.
Health-related quality of life (HRQoL)	Refers to the impact of the health aspects of an individual's life on that person's quality of life, or overall well-being; also used to refer to the value of a health state to an individual.
Healthy-years equivalent (HYE)	Number of years of perfect health (followed by death) that has the same utility as (is seen as equivalent to) the lifetime path of health states under consideration. It can be measured by two *standard gamble* questions or by one *time trade-off* questions.
Indirect cost	Term previously used for production losses (see *production losses*).
Intangible cost	Value of health and quality of life lost due to a disease. These costs are not strictly intangible as they can be measured and valued through the utility or *willingness-to-pay* approach.
Internal cost	A cost arising from an activity which accrues to the person carrying on the activity. Example: Health damage inflicted to smokers by themselves. (see *externalities*)
Multicollinearity	Statistical phenomenon in which two or more predictor variables in a multiple regression model are highly correlated. It reduces the precision with which parameters can be estimated
Natural experiment	Naturally occurring instance of observable phenomena which approximate or duplicate the properties of a controlled experiment. Example: Data on cigarette consumption in two comparable cities but different smoking regulations.
Non-experimental data	Data not resulting from a controlled scientific experiment but collected in the natural or social environment.

Ordinal scale property	As used here, a scale assigning numbers to health states so that the numerical order of greater than or less than implies “preferred to” or “not preferred to”, but for which numerical differences are not meaningful with respect to how much more or less preferred.
Preference weight	Numerical judgement of the desirability of a particular outcome or situation; also known as preference score or value.
Presenteeism	Reduced productivity at work due to disease or accident
Production losses	Production losses due to workdays lost as a consequence of a disease or accident.
Quality of life	Broad construct reflecting subjective or objective judgement concerning all aspects of an individual’s existence, including health, economic, political, cultural, environmental, aesthetic, and spiritual aspects.
Quality-adjusted life expectancy	Life expectancy computed by means of quality-adjusted life years rather than nominal life years.
Quality-adjusted life years (QALYs)	Measure of health outcome which assigns to each period of time a weight, ranging from 0 to 1, corresponding to health-related quality of life during that period, where a weight of 1 corresponds to optimal health and a weight of 0 corresponds to a health state judged equivalent to death; these are then aggregated across time periods.
Regression analysis	Statistical modelling technique (there are numerous types), used to estimate or predict the relative influences of more than one variable on another.
Sensitivity analysis	Approach for exploring how uncertainty impacts on study results.
Standard gamble	Respondents are presented with a choice between an intermediate health state and a gamble between full health and death. The probability of death is varied until a point of indifference is reached between the two choices.
Systematic review	Literature review focused on a single question which tries to identify, appraise, select and synthesize all high quality research evidence relevant to that question.
Time trade-off	Method of measuring health-state utilities in which patients are asked to trade off life years in a state of less-than–perfect health for a shorter life span in a state of perfect health. The ratio of the number of years of perfect health that is equivalent to longer life span in less-than-perfect health provides a measure of the preference for that health state.

Trend	Long-term growth path of variable, around which there may be short-term fluctuations.
Visual analogue scales	Direct rating methods using a line on paper (or similar visual device) without internal markings. Raters are asked to place a mark at some point between the two anchor states appearing at the ends of the line.
Willingness-to-pay (WTP)	Method of measuring the value an individual places on an item, service, or reduction in the risk of death and illness by estimating the maximum amount of money the individual would pay in order to obtain the item, service, or risk reduction.
Years of Healthy Life (YHL)	The duration of an individual's life, as modified by the changes in health and well-being experienced over a lifetime, also called 'health-adjusted life years'. (see *QALYs*, *DALYs*)

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Appendix: Methodological checklists and recommendations

Referees' checklist (also to be used, implicitly, by authors) – Drummond and Jefferson (1996)

	Item	Yes	No	Not clear	Not appro-priate
Study design					
1	The research question is stated	□	□	□	
2	The economic importance of the research question is stated	□	□	□	
3	The viewpoint(s) of the analysis are clearly stated and justified	□	□	□	
4	The rationale for choosing the alternative programmes or interven-tions compared is stated	□	□	□	
5	The alternatives being compared are clearly described	□	□	□	
6	The form of economic evaluation used is stated	□	□	□	
7	The choice of form of economic evaluation is justified in relation to the questions addressed	□	□	□	
Data collection					
8	The source(s) of effectiveness estimates used are stated	□	□	□	
9	Details of the design and results of effectiveness study are given (if based on a single study)	□	□	□	□
10	Details of the method of synthesis or meta-analysis of estimates are given (if based on an overview of a number of effectiveness studies)	□	□	□	□
11	The primary outcome measure(s) for the economic evaluation are clearly stated	□	□	□	
12	Methods to value health states and other benefits are stated	□	□	□	□
13	Details of the subjects from whom valuations were obtained are given	□	□	□	□
14	Productivity changes (if included) are reported separately	□	□	□	□
15	The relevance of productivity changes to the study question is dis-cussed	□	□	□	□
16	Quantities of resources are reported separately from their unit costs	□	□	□	
17	Methods for the estimation of quantities and unit costs are described	□	□	□	
18	Currency and price data are recorded	□	□	□	

19	Details of currency of price adjustments for inflation or currency conversion are given	□	□	□	
20	Details of any model used are given	□	□	□	□
21	The choice of model used and the key parameters on which it is based are justified	□	□	□	□
Analysis and interpretation of results					
22	Time horizon of costs and benefits is stated	□	□	□	
23	The discount rate(s) is stated	□	□	□	□
24	The choice of rate(s) is justified	□	□	□	□
25	An explanation is given if costs or benefits are not discounted	□	□	□	□
26	Details of statistical tests and confidence intervals are given for stochastic data	□	□	□	□
27	The approach to sensitivity analysis is given	□	□	□	□
28	The choice of variables for sensitivity analysis is justified	□	□	□	□
29	The ranges over which the variables are varied are stated	□	□	□	□
30	Relevant alternatives are compared	□	□	□	
31	Incremental analysis is reported	□	□	□	□
32	Major outcomes are presented in a disaggregated as well as aggregated form	□	□	□	
33	The answer to the study question is given	□	□	□	
34	Conclusions follow from the data reported	□	□	□	
35	Conclusions are accompanied by the appropriate caveats	□	□	□	

Recommendations for improving the evidence on cost-effectiveness in public health – Drummond et al. (2008)

Attribution of Outcomes

1. Where possible, analysts should seek to conduct RCTs of public health interventions, as a source of evidence on relative effectiveness.
2. Bearing in mind the need for extrapolation of outcomes beyond the end of the trial, the outcomes measured should match those available in longer term observational studies.
3. Where RCTs cannot be undertaken, or are currently absent, natural experiments and non-experimental data should be used to fill gaps in the evidence base.
4. In economic evaluations all relevant evidence should be considered, including the synthesis of evidence from studies of different experimental and non-experimental designs. Further research should be conducted into the methods of achieving this.
5. More use should be made of techniques that have been developed to analyse non-experimental data, such as propensity scores, difference in differences techniques, time series analyses of natural experiments and, where appropriate, more sophisticated econometric modelling and structural simulation modelling.

Measuring and Valuing Outcomes

6. There should be more debate about the theoretical and value propositions underlying the various forms of economic evaluation, and their appropriateness for assessing public health interventions.
7. In all cases a cost-consequences analysis should be performed, prior to proceeding to the valuation of the various outcomes of public health interventions.
8. Research should be conducted into the practicalities of applying the intersectoral compensation test approach […]
9. Research should continue both into the development of a more generic measure of well-being, that could be applied in the evaluation of a wide range of public sector interventions, and sector-specific generic measures of outcome.

Equity Considerations

10. Pilot studies should be conducted of health inequality impact assessment for selected public health interventions, chosen on the basis that there exist detailed individual-level data on equity-related subgroups.
11. In situations where the most cost-effective option is likely to be judged inequitable, either on the grounds of health inequality impact or procedural justice, estimates should be made of the opportunity cost of not selecting that option, in terms of aggregate health gains forgone or additional resources used.
12. Primary research should be conducted on the effectiveness of interventions designed to tackle health inequality, combining knowledge and tools from social epidemiology and econometrics.
13. Further research should be conducted on equity weighting, focusing on equity considerations and contexts relevant to public health, as opposed to health care more generally. In particular research is warranted on equity considerations relating to socio-economic status, the degree of voluntari-

ness or personal responsibility for health risk, the value of treating current ill-health versus preventing future health risk and the aspects of health inequality that the general public is most concerned about.

Intersectoral Costs and Consequences

14. The intersectoral impacts of public health interventions should be quantified (or at the very least described qualitatively), in a cost-consequences analysis, in the way that makes the most sense for each sector. Ideally each sector would use a well-understood generic measure of outcome, in reference to which the shadow price of the budget constraint in the sector could be expressed.

15. Although public sector decision makers are mostly concerned with the impacts of interventions on public sector budgets, there should be more consideration of impacts on the voluntary sector and private individuals, since taking this broader view may be required to assess more fully the effectiveness of programmes and to identify the equity implications arising from implementation.

16. In evaluating public health interventions, an analysis should be conducted of the costs and consequences by beneficiary group. These groups could be defined in terms of health status, socio-economic status or other characteristics, depending on policy relevance.

17. Research should be conducted to assess whether a general equilibrium approach is more suitable for the evaluation of public health interventions having a wide range of intersectoral costs and consequences.